

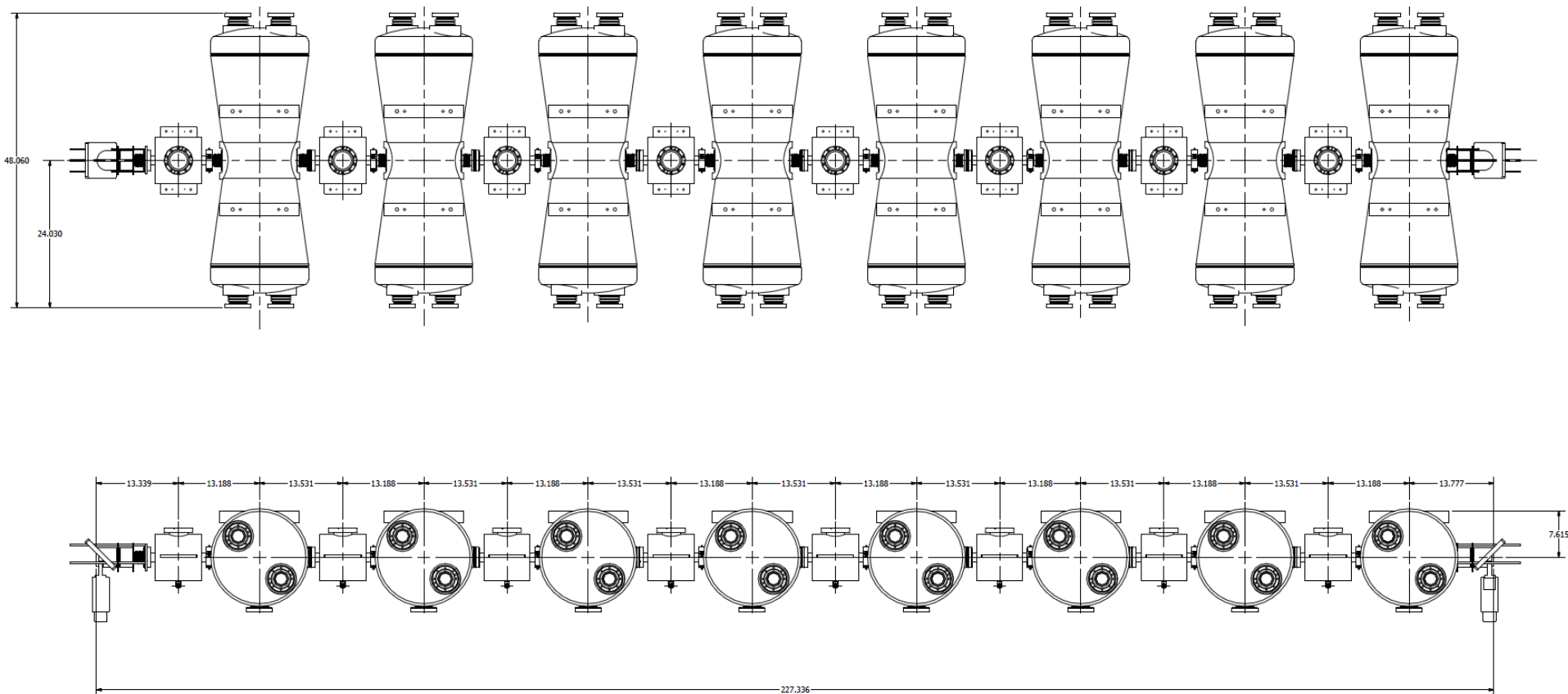
# Solenoid Considerations for PXIE 162.5 MHz HWR Cryomodule

Mike Kelly

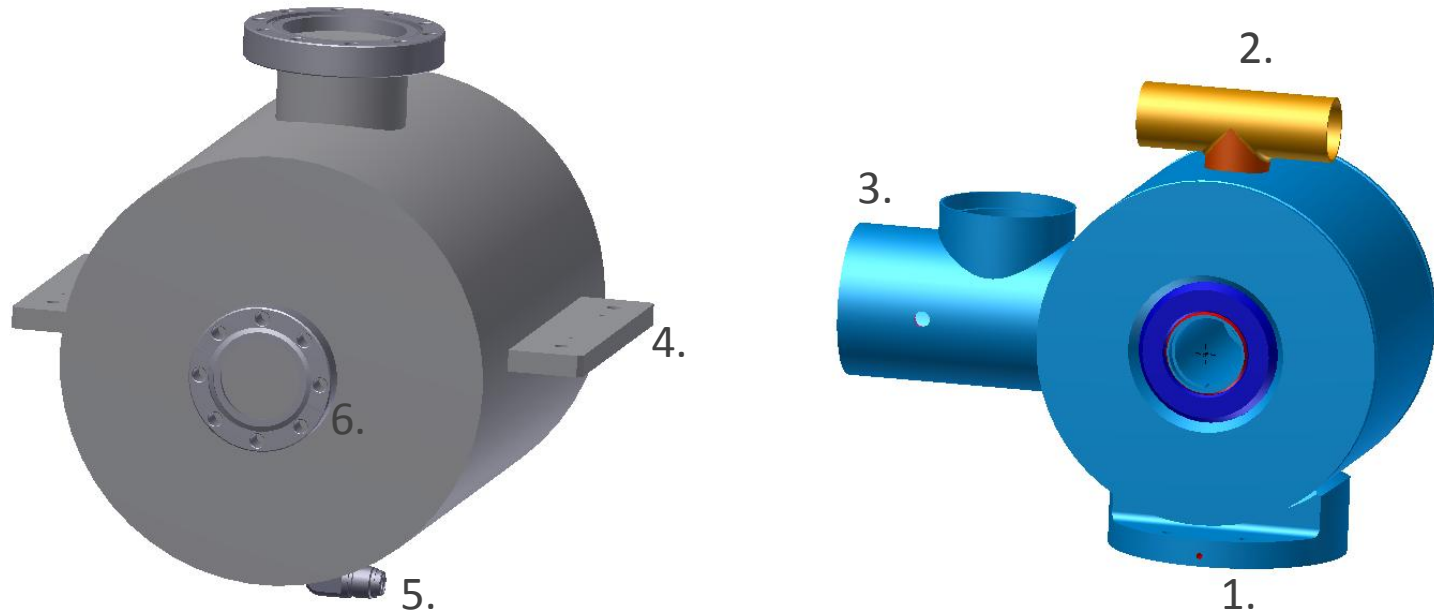
Physics Division

February 17, 2012

# 162.5 MHz Cavity/Solenoid/BPM



# ANL (left) and HINS (right) solenoid concepts

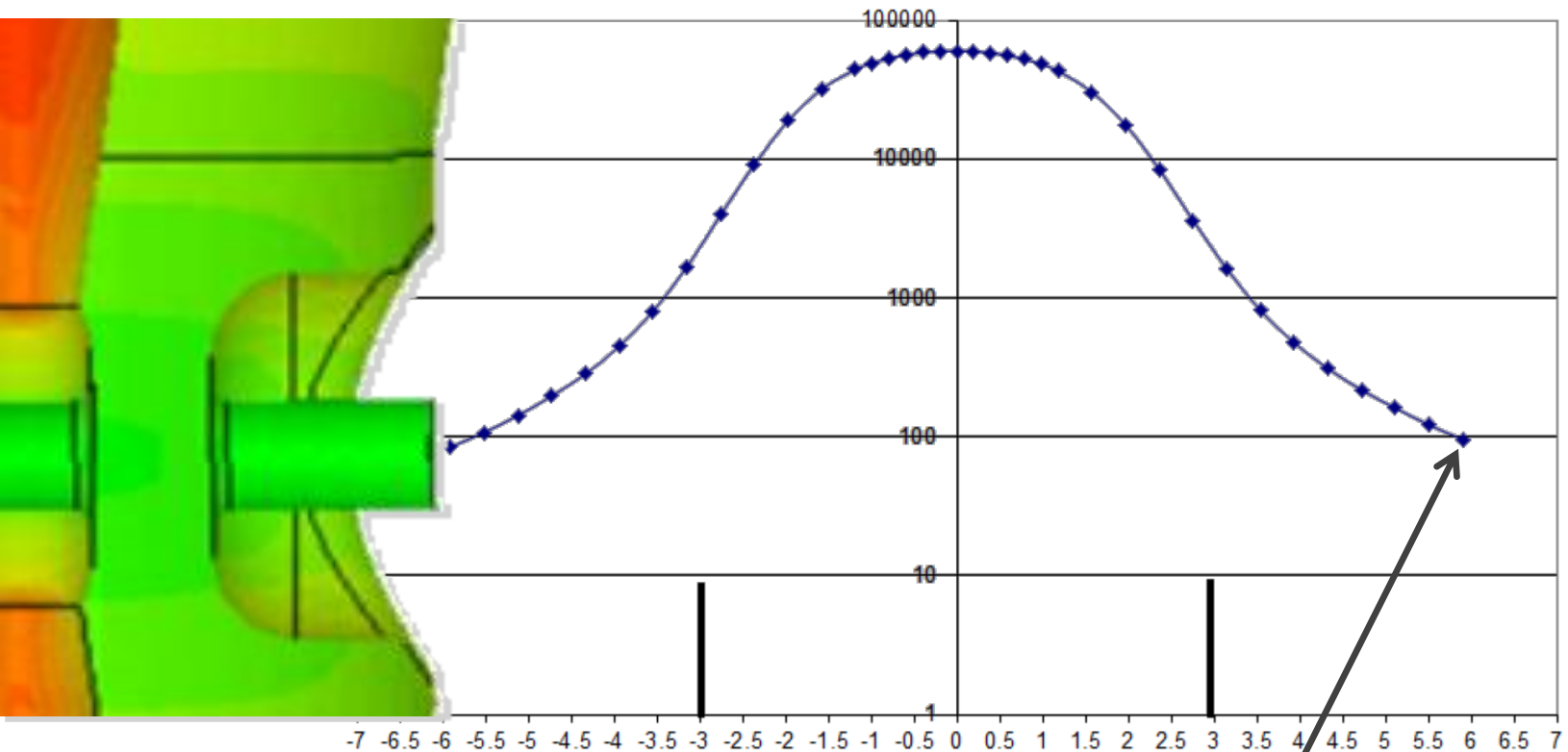


Modifications to HINS solenoid to fit into ANL cryomodule approach

1. Remove HINS base mount
2. Remove tee on top of HINS solenoid
3. Modify/remove and redo helium connection port
4. Weld on and machine ANL mounts
5. Weld on ANL cooldown port on bottom of solenoid
6. Weld on beam port nipple/conflat

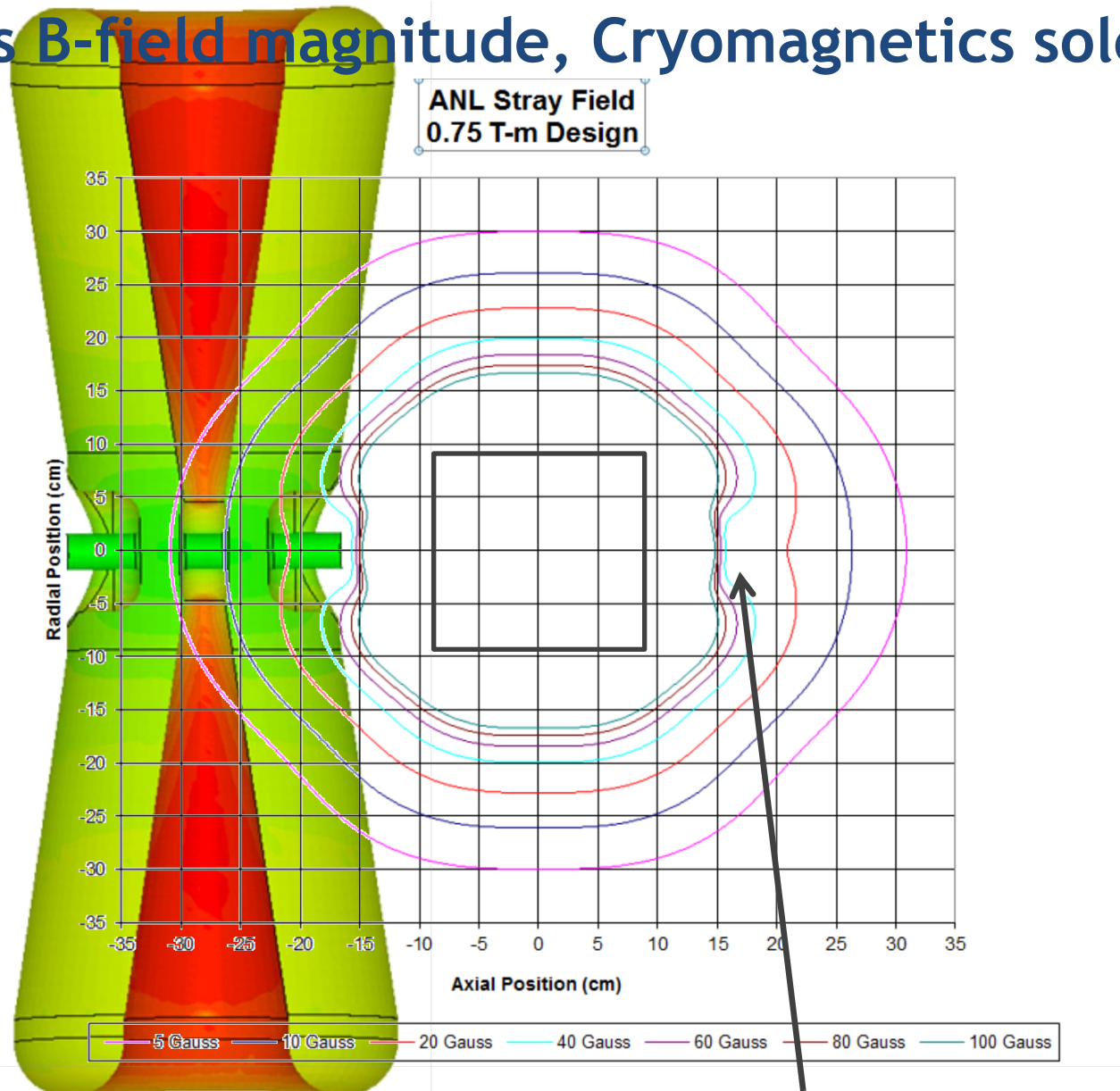
***No cost savings realized from existing helium jacket; in fact, ~\$2K to remove existing vessel***

# On-axis B-field magnitude, HINS solenoid



For central field of 6 T fringe field is ***~100 Gauss at 3 inches***

# On-axis B-field magnitude, Cryomagnetics solenoid



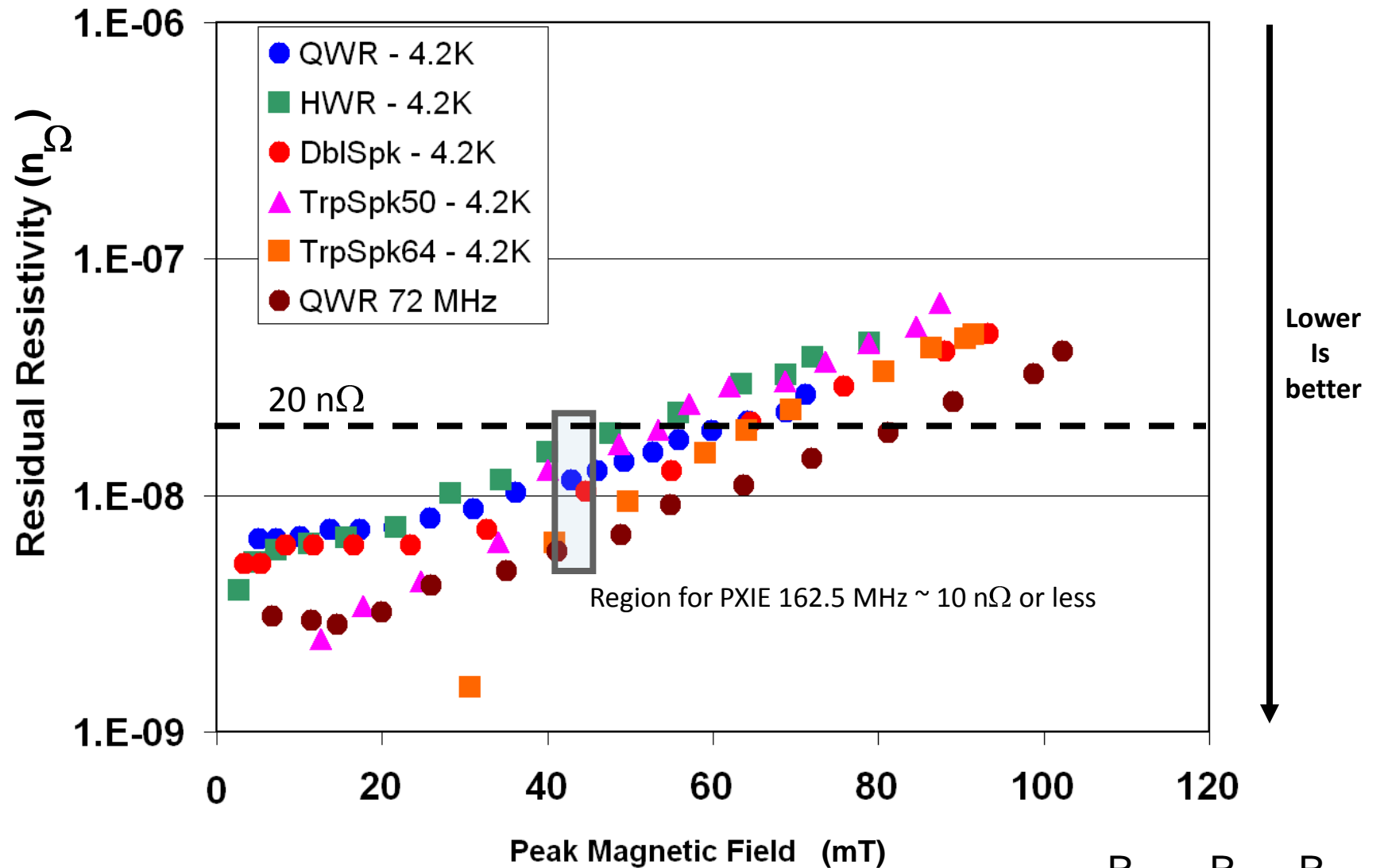
For central field of 6 T fringe field is **~30 Gauss at 3 inches**

# Increase in $R_s$ due to trapped flux on cooldown

- Approximately  $0.1 \text{ n}\Omega$  per mGauss for 162.5 MHz
- Contribution due to penetration of earth's field
  - $\sim 15 \text{ mG}$  gives  $1.5 \text{ n}\Omega$ , i.e. pretty small
- Strong preference for no substantial residual magnetization of solenoid or other components in the cryomodule
  - Substantial means more than  $\sim 30 \text{ mG}$  ( $1/2 \text{ Watt/cavity}$ ) at the position of the cavity



# Surface magnetic field and $R_{\text{RES}}$ in ANL Cavities



$$R_{\text{RES}} = R_{\text{TOT}} - R_{\text{BCS}}$$

# Unit Cost for Magnetic Shield

----- Original Message -----

From: Brad Friestedt <[bfriestedt@magnetic-shield.com](mailto:bfriestedt@magnetic-shield.com)>

To: Mike Kelly <[kelly@phy.anl.gov](mailto:kelly@phy.anl.gov)>

Sent: Monday, February 11, 2002 4:12 PM

Subject: re[2]: Flat Pattern Drawing for Cylinder

> I look forward to receiving the flat pattern from your drafting

> person. We

quote \$5200.00 for the cylinder with end plates. Delivery will be 5 weeks.

Material is .062" CO-NETIC AA Alloy. The three parts will be annealed after fabrication. Stainless steel 10-32 screws and nuts will secure both end plates, 10 per end.

>

>

> Regards, Brad Friestedt

> ([bfriestedt@magnetic-shield.com](mailto:bfriestedt@magnetic-shield.com))

> Magnetic Shield Corporation

> 630-766-7800

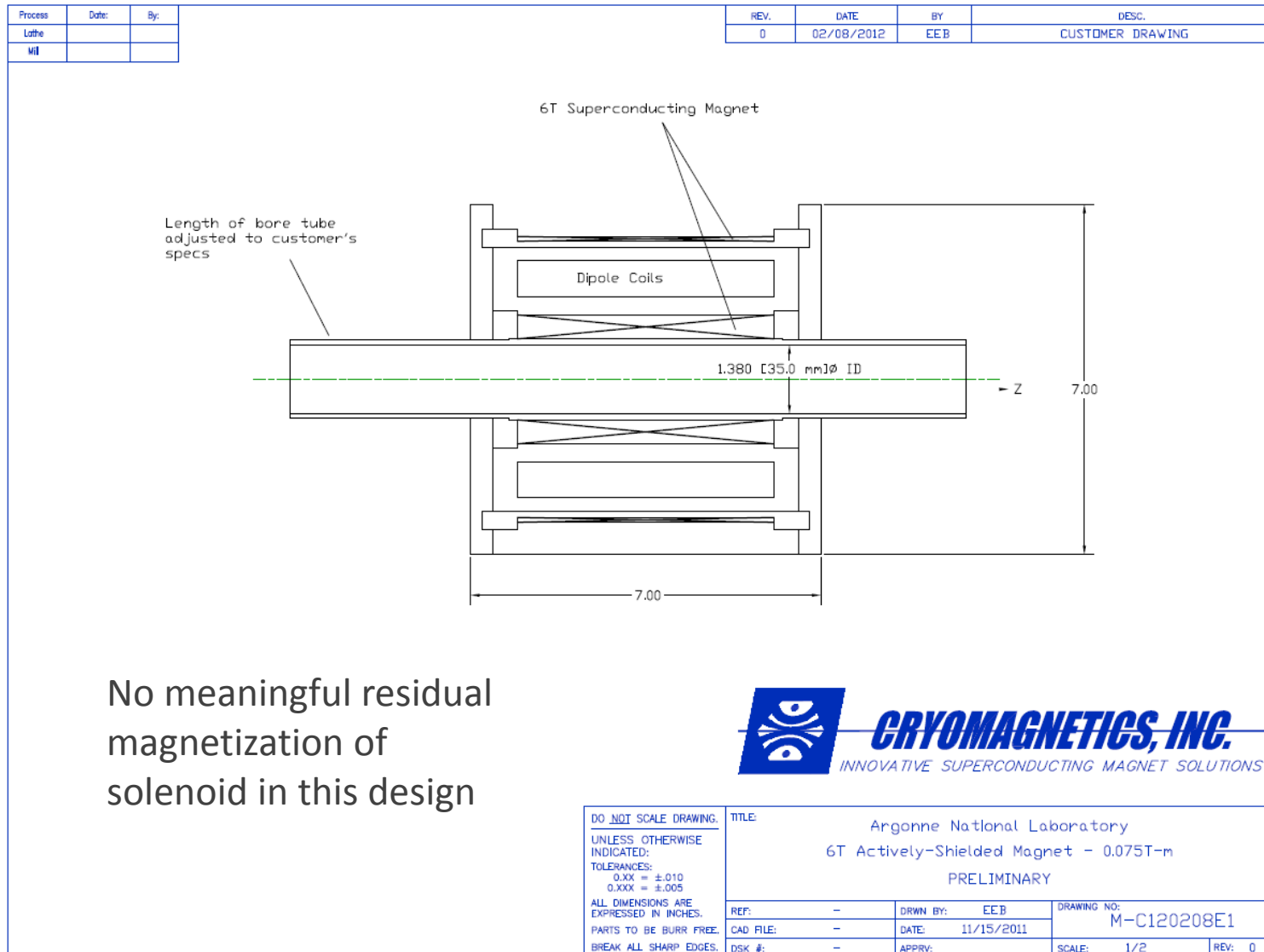
> 630-766-2813fax

>

- Multi-piece shield will require some design effort
- Unit cost (M&S only) will conservatively be in the range of \$5K-\$10K/cavity



# Cryomagnetics 0.75 T-m SC solenoid



# Cryomagnetics 0.75 T-m SC solenoid



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**To:**

Michael P. Kelly  
Argonne National Laboratory  
mkelly@anl.gov

## **QUOTATION**

Date: February 8, 2012

Quotation #: E20208A

Your Request #: Email of Feb. 6th

Item	Quantity	Description	Unit Price	Total
A	9 each	<p><b><u>6T Superconducting Magnet, 0.75T-m Field Integral</u></b></p> <p>Active-shielded, superconducting solenoid using twisted, multifilamentary NbTi wire with a copper matrix. All coils are fully epoxy impregnated to prevent training.</p> <p>Operating temperature: 4.6 Kelvin                      Rated magnetic field integral: <math>\int B_z dz = 0.75 \text{ T-m}</math>                      Operating current: ~79 amps                      Inductance: 1.1 henries                      Shielding: <math>B &lt; 100\text{G}</math>: <math>z \geq 15\text{cm}</math>  <math>r \geq 17\text{cm}</math></p> <p>Steering coils: 0.2T                      30 T-mm field integral                      Bore diameter: 35 mm</p>	\$26,500.00	<u>\$238,500.00</u>



# Bottom Line

- HINS solenoid helium jacket is not suited as is for the ANL cryomodule
  - Modest additional total cost (\$20K M&S + \$20K effort) to make useable for ANL cryomodule
- Magnetic shielding would be costly in both time and materials (\$60K M&S + \$40K effort conservatively)
- Total Incremental cost of new solenoids ~\$100K
- My opinion: ***A good part of the total cost of new solenoids is lost in addition time and materials; adds modest uncertainty to cavity/cryomodule performance; people resources for ANL are very tight; if the HINS solenoid were a close fit then it makes sense to use them; they are not a particularly close fit***

